Trends and Distribution of Benthic Debris in Puget Sound: What's Thrown In, Stays There!

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Introduction

Benthic debris is discarded human-made material found on or embedded in the subtidal benthos. Various laws have been enacted laws to eliminate or minimize the extent of litter, derelict fishing gear, and other human debris in marine environments, but few studies exist to evaluate the impact of the laws or magnitude of benthic debris. WDFW has conducted fish surveys using bottom trawls throughout Puget Sound. Since 1989, benthic debris encountered in the trawls has been recorded, and just as for fish populations, the magnitude of benthic debris has been estimated using survey design protocols.

Methods

Groundfish Trawl Surveys consisted of chartering a commercial fishing vessel that towed a standardized research trawl along the bottom of the sea floor at predetermined stations for approximately 10 minutes. The Groundfish Trawl Surveys were based upon a systematic design stratified into four depth zones (30 ft to 120 ft, 121 ft to 240 ft, 241 ft to 360 ft and greater than 360 ft) and were conducted in five regions within Puget Sound on a sporadic basis. During 1989 and 1991 five regions were surveyed each year (exclusive of the San Juan Islands) and individual regions were surveyed infrequently thereafter. The Strait of Georgia and adjacent waters were surveyed in 1994 and 1997, central Puget Sound in 1994, Hood Canal in 1996, south Puget Sound in 1996, and the eastern Strait of Juan de Fuca in 2000. Between 8 and 40 trawl samples were taken in a region per year, and all surveys were conducted during the spring.

For each trawl sample, the area swept by the net at the station was determined by measuring the length of the path that the vessel fished and by multiplying this length by the width of the net opening determined from the depth and length of the deployed tow cable. After the net was retrieved, the man-made debris that was encountered in the net was recorded, weighed, and categorized as plastic, glass, aluminum, fishing gear, and other debris. The density of benthic debris was then determined for each trawl sample by dividing the debris weight by the area swept by the net. Total estimates of debris were made by multiplying the average debris densities from each stratum by the total sea floor area of each stratum. Debris was also recorded during trawling conducted for the Puget Sound Ambient Monitoring Program (PSAMP), and debris densities were used to further identify the distribution of debris in Puget Sound.

Results

Since 1989, 478 tows have been made throughout Puget Sound (except the San Juan Islands). Benthic debris was collected at over 130 of these trawl stations (Figures 1 and 2). The most frequent accumulations of debris were found in shallow depths or near urban areas. One thousand metric tons of benthic debris lies on the bottom of Puget Sound (Figure 3), the greatest mass of debris of any region occurred in the Strait of Juan de Fuca. Of the five debris categories, the "other debris" category constituted the greatest mass and typically consisted of large tires, tanks, and pilings (Figure 4). Although there was some suggestion of an increasing trend in debris amounts, the high variation of the estimates precluded determining a statistical trend.

Implications and Discussion

Benthic debris occurs in substantial amounts in Puget Sound, and the greatest mass of debris was in the Strait of Juan de Fuca, where several large items accounted for much of the debris estimate. How benthic debris impacts habitat or fish populations is not known, especially in the nearshore environment. Some debris may offer organisms vertical structures, hard substrates, and crevices for orientation, settling, or

hiding. However, some of the material may leach toxic compounds, entrap and kill animals, or otherwise preclude marine plants or animals from utilizing natural habitats.

While the data are highly variable, trawl surveys offer a means to evaluate the impacts of litter and dumping in Puget Sound. Trawl surveys are limited, however, by excluding extremely large and small objects, by not capturing materials firmly attached or embedded in the substrate, and by the shallow depth limitations of operating the trawl. Although a clear trend in the amount of benthic debris over time was not observed, the suggestion of an increasing trend indicates that existing pollution laws do not appear to be affecting the amount of debris in Puget Sound. The surveys prior to 1991 had low sampling effort compared to intense regional surveys initiated in 1994. Continued surveys with higher sampling power will be better able to evaluate trends and the effectiveness of anti-littering laws and clean up efforts.

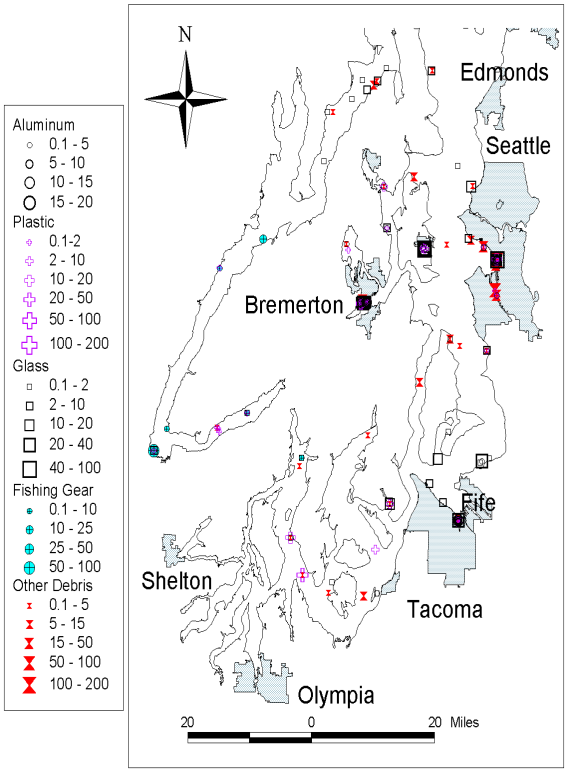

Figure 1. Density and distribution of benthic debris in southern Puget Sound.

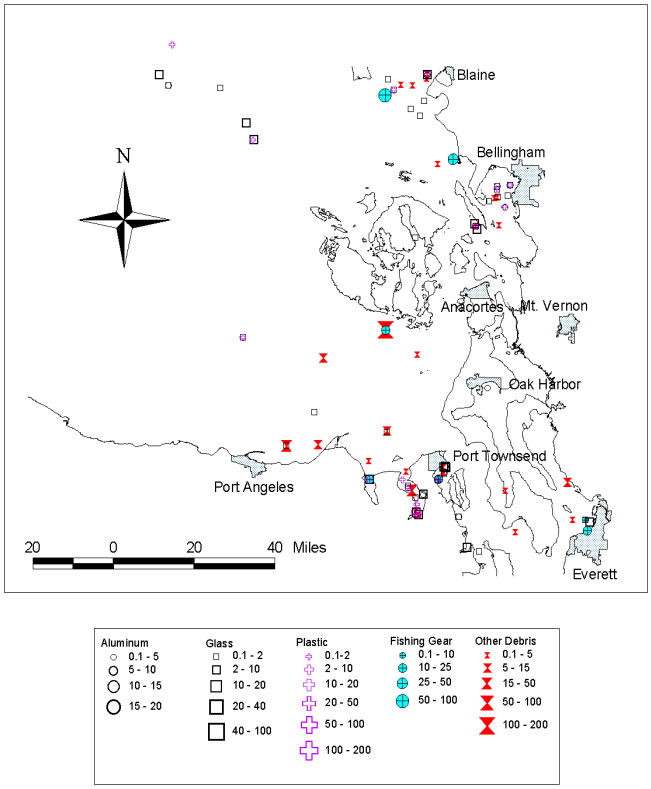

Figure 2. Density and distribution of benthic debris in northern Puget Sound.

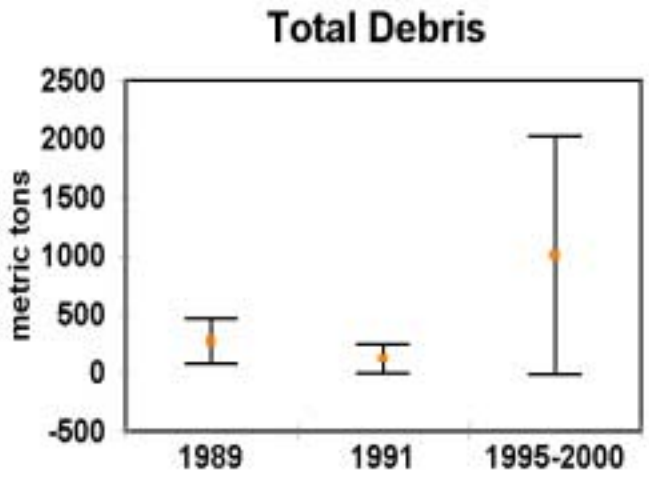

Figure 3. Total debris (mt) and 95% confidence limits estimated from Groundfish Trawl Surveys in Puget Sound.

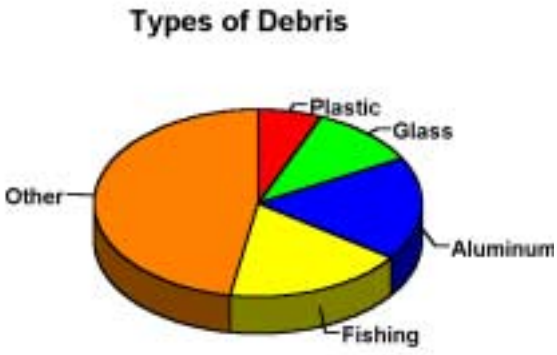

Figure 4. Proportion of benthic debris by category estimated from Groundfish Trawl Surveys in Puget Sound.